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Evaluation of stroke impairment using time series analysis

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A stroke is an acute brain injury that can affect many body functions, often causing motor, speech, memory, vision and other sensory impairments. Rehabilitation is an important part of stroke recovery and the key to successful rehabilitation is an accurate assessment of stroke-caused impairment [1,2]. Current clinical assessments generally involve physical assessment and visual observation by physicians. Therefore, assessment results are inherently subjective and potentially inconsistent among physicians. Moreover, current assessment tools are not adequate to reliably discriminate between different levels of performance. Thus, in practice the majority of stroke patients follow the same general rehabilitation program, which may not necessarily be optimal for each individual case.

The major goal of this research is to develop advanced technologies that can provide objective and accurate measurements of stroke-caused impairments and that can aid clinicians in the planning of individual rehabilitation therapy for stroke patients. The key technology in this research is a KINARM (Kinesiological Instrument for Normal and Altered Reaching Movements) robot that allows for the collection of quantitative measurements of upper limb movements of a subject performing a particular task [3]. This abstract presents a technique for the evaluation of stroke impairment using time series analysis of the data collected with the KINARM robot. The data were collected from controls (people with no neurological disorders) and stroke subjects. Each subject underwent a typical conventional stroke assessment and a center outreach task in the KINARM robot for each arm. In the center outreach task the subjects were instructed to move the examined arm quickly and accurately from the central target to the illuminated target, and to maintain the hand at the target for the remainder of the trial (Figure 1).

The collected data for each of eight individual reaching movements to eight different targets was represented as a time series. Qualitative comparison showed that majority of the stroke patients had different reaching trajectories than the controls, with less striking differences for the less impaired patients. A cross correlation between a reaching movement to a target and a line fitted through the data obtained from the control group can be computed using a Fourier transform. A low correlation value would indicate a higher degree of upper limb motor impairment.

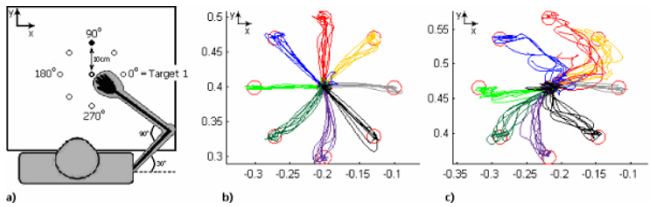

Figure 1
The center outreach task. a) In this task the subject is asked to move one hand from the center position to one of eight targets at which a light is illuminated. b) Reaching trajectories of a control subject (left, non-dominant arm). c) Reaching trajectories of a stroke subject (left, non-dominant, stroke-affected arm).

Therefore, the technique facilitates the detection of abnormalities in the movements of stroke patients and may be used as a feature for the classification of stroke patients.

References

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